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Inside . . .

Exterior finishes on any building have to stand up to extreme conditions. In most cases, exterior materials are designed to be forgiving. Some, however, require more care. The greater use of synthetic stuccos recently highlights the need to do it properly. We review EIFS systems, and some of the issues of concern.

Carpet staining is an irritant that points out how important it is to built it right. We review what may be causing the problem, and how to avoid it.

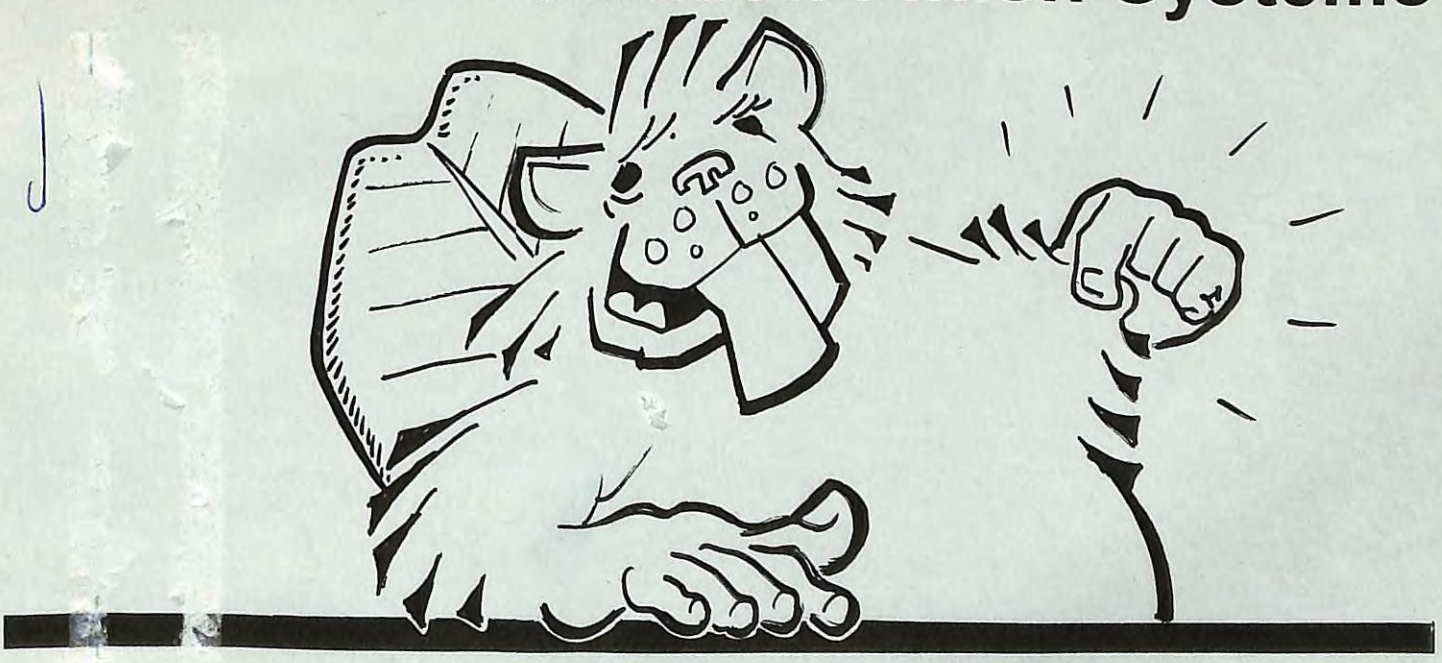
Peter Moffat makes a case for the need to pay more attention to the air sealing of new houses.

Other items include a report on the NAHB Builders' Show; EMR/CANMET News presents updates on the B.C.Advanced House and the Maison Novtec; TRC news and more.

Contents . . .

Exterior Insulation Finish Systems (EIFS)Problems, Causes and Solutions....3
Carpet Staining....5
The Bermuda Triangle: Airtightness, Ventilation, and Insulation....6
The Builders' Show: 1993 NAHB Show in Las Vegas....9
EMR/CANMET News....10
B.C. Advanced House Ventilation....10
Advanced Houses at the Marketplace of Ideas....11
Maison Novtec Update....11
Technical Research Committee News....12
House Construction Costs 1977 vs 1991....12
Combined Ventilation & Forced Warm Air Heating Systems: do they work?....14

Exterior Insulation Finish Systems



From the Publisher . . .

Aggressive sales, governed by the lowest price at all costs seems to be the way of doing business today. In the search to offer the cheapest price a fundamental principle has been forgotten; something that was highlighted so delightfully in the movie "*Back to the Future*" with Michael J. Fox. What am I referring to? Customer service.

The lack of customer service we see today has made it seem normal, which is why the service shown in the movie struck us as amusing. Yet the kind of service shown was common only a generation ago. You only have to go shopping in any mall these days to see how little service there is. You may be able to accept less service in a retail environment where you can touch and feel the items before buying them, and most items are identical.

Yet there are many products we use today that can't be just picked up off the warehouse floor and installed without that extra back-up service. Remember the first computer you bought? You just plugged it in and could use instantly, right? (Well, if you are a naturally born hacker you could, but most of us aren't, and were lost for a long time). I've heard that in some areas in the US furnaces are being sold at cash-and-carry building materials. Any bets what kind of back-up or technical service will be available to purchasers?

How much help have you received from your suppliers lately? I suspect that many of you continue to deal with some businesses even if they are more expensive simply because they offer good service, going that extra step, being able to answer technical questions, or whatever.

The non-existent customer service from suppliers came to light recently as I was following up with a customer for whom I had designed their new home. The heating system, a high efficiency gas fired boiler that also provides hot water, wasn't working. We discovered that the flue was damaged, so that short circuiting supply air and flue gasses were shutting off the unit, as it was designed to do. In trying to fix the problem, the builder and the sub-trade were having trouble getting answers to technical questions about the unit from the supplier or the manufacturer.

It seems the local supplier was quite happy to sell product, but was unable to provide back-up service. They had no information about the equipment they were selling. The builder had to make calls to the factory (in the USA) and even that was like a search for a needle in a haystack.

Perhaps it's time to start rethinking how we do business. Let's not forget the importance of customer service.

Richard Kadulski
Publisher

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Exterior Insulation Finish Systems (EIFS)

Problems, Causes and Solutions

Stucco has been used for a long time. Recently synthetic stucco materials have become popular in North America since they were first introduced from Europe in the late 1960's, and are now used both in low and high-rise construction.

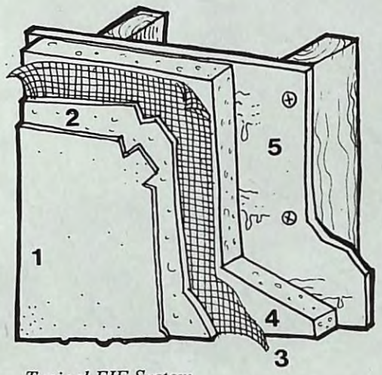
Recently there have been many reports of problems with stucco finishes. In the eastern US many application are in litigation. In B.C., the New Home Warranty Program has launched an enquiry into stucco materials as a result of water leakage problems that are affecting many low rise housing projects. In most cases, the failures can be traced to poor detailing and installation of materials.

Exterior insulation and finish system (or EIFS) is the generic description for acrylic stucco. It typically consists of plastic insulation board, glass fibre reinforcing mesh and synthetic stucco. Several manufacturers make the product and each has some product specific variations. Builders will recognize them by their trades names, which include Dryvit, Preswitt, Insul/Crete and Swiss-Tex.

EIFS originated in Germany after World War II. About 12 million square meters are installed every year. About 80 to 90% of all EIFS installed in Europe use expanded polystyrene foam board, most placed directly over masonry or poured concrete substrate.

Other than the use of new product formulations and insulations, EIFS has many of the basic characteristics of traditional stucco construction. The attraction of EIFS is the relatively low capital cost for installation - especially in the case of larger multi family and multi story buildings (where conventional stucco may not even be practical), and the greater flex of the finish compared to the more brittle conventional cement stucco. Properly applied these products create a durable and attractive finish and allow extra flexibility for decorative treatments.

As all exterior materials, EIFS cladding must withstand wind loads, solar radiation, thermal and moisture movement as well as wind driven rain over a long period of time. Because the exterior surface of a building sees severe environmental conditions, any flaws in workmanship, design or damage to exterior joints or surfaces may lead to loss of control over the movement of air, vapour and water.



Typical EIF System
1 Finish coat
2 Base coat
3 Fibreglass or nylon mesh
4 EPS board
5 Sheathing

EIFS cladding are face sealed finishes. The exterior surface and joints must remain weather tight over the service life of the building so they require high levels of workmanship and maintenance. However, there is no consensus on the long term service life of EIFS. Durability seems to depend on the system design, workmanship and quality control used during the construction process and maintenance over the life of the building.

Known failures of EIFS are the result of either faulty installation (the vast majority) or faulty detailing.

Warranties for EIFS are limited to materials only when applied according to the EIFS manufacturer's directions on substrate approved by the manufacturer. They are usually for 3 years and are limited to replacement of defective materials. Some EIFS manufacturers have training programs for the contractors who use their products and most supply consulting at the design and construction phases to ensure correct application of their products.

Home Warranty programs and building officials are trying to grapple with problems where there have been failures and new regulations have arisen as a result. However, there are no national standards for the correct application of EIFS. In France, a performance standard has been developed for EIFS. The Ontario Ministry of Housing has produced a Specification/Checklist for both prefabricated and field applied EIFS.

EIFS Problems

Moisture, primarily the wetting of the substrate and its subsequent softening, delamination or warping of the substrate, is the major contributor to EIFS failures. Typical EIFS used in North America consists of expanded polystyrene foam insulation board applied to an exterior drywall sheathing. Common problems include:

Separation of EPS board from its substrate.

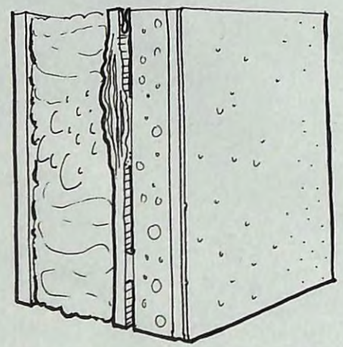
This can be caused by moisture on the substrate softening or delaminating gypsum board sheathing, expanding and warping of OSB or plywood sheathing, and corrosion of metal insulation board fasteners. Moisture gets on the substrate by rain exposure during construction; rain penetration of joints and cracks in the exterior of the EIFS; or condensation of interior moisture on the inside face of the substrate.

Bond failure of the adhesives can be caused by on-site changes of acrylic adhesive during construction (such as adding more cement, sand or water than specified); over-mixing of the adhesive; inadequate preparation of substrate; or freezing of the adhesive before proper set takes place.

Curling of the expanded polystyrene board can be caused by the application of EPS board before it is fully cured or the rapid thermal cooling of the outside skin before the adhesive has set up.

Cracks through finish and base coats

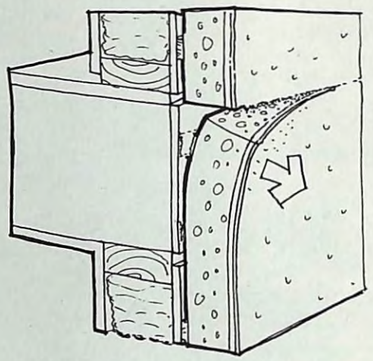
Cracks in the acrylic finish will happen when it's tensile strength is exceeded, and can be caused by differential expansion rates of the insulation board and the acrylic finish, shrinkage of the finishes when curing, or movement in the structure. Most of the cracks that happen over the face of EIFS panels are hair line cracks due to shrinkage that are controlled by the fibreglass reinforcing mesh.



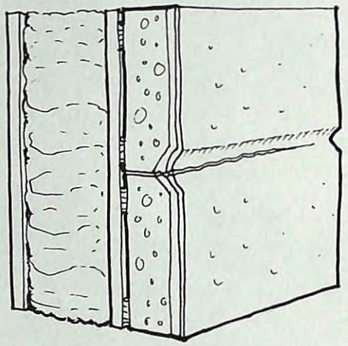
Delamination of drywall sheathing due to wetting

Visible cracks can happen where stresses are concentrated, such as around windows, at corners and in areas where the base coat is thicker. The larger cracks allow water penetration and are due to any of the following:

- Thickening of base coat due to penetration into a gap between insulation boards.
- Thickening of the base coat at "v" joints placed in the foam for decorative reasons
- Lack of reinforcing mesh
- Base coat or finish coats applied too thinly



Curling of foam board



Joint failure due to thickening of base coat causes stresses

Avoiding Problems

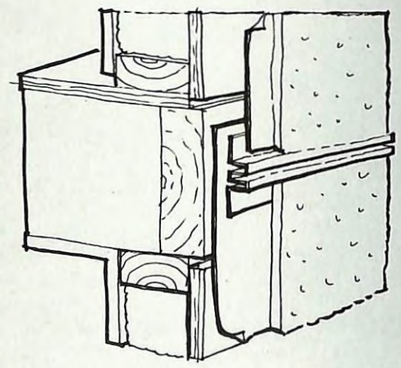
The best way to avoid stucco problems, EIFS or conventional, is to install it properly. This requires a good quality control, a strict adherence to manufacturer's recommendations and careful attention to detailing. We know that Murphy shows up on every job site, so if something can go wrong, it will. This is why many building systems have redundant elements. Canadian Building Digest #48 (*Requirements for Exterior Walls*, first published in 1963), outlines the main requirements for exterior walls. Key among these as the need to control heat flow, control air flow, control water vapour flow and control rain penetration.

When applying these principles to wall cladding, the rain screen concept was described in Canadian Building Digest #40 (*Rain Penetration and its Control*, 1963). It points out that "*it is not conceivable that a building designer can prevent the exterior surface of a wall from getting wet nor that he can guarantee no openings will develop to permit the passage of water...*"

The rain screen prevents the wetting of the wall or air barrier of the building by incorporating an air chamber where the air pressure is always equal to the outside, thus stopping the driving forces for water penetration. This also makes it easier to handle cladding movements due to wetting and thermal stresses, not unlike traditional wood clapboard or shingle siding, which are very porous but effective at presenting a weather barrier.

Does this mean that stucco won't work? Typically, stucco does not employ a rain screen, but instead it is a single element that relies on the exterior seal. However, by careful detailing, it can be installed as a rain screen.

Exterior Insulation and Finish Systems (EIFS) Problems, Causes and Solutions by Christopher Mattock prepared for CMHC



Doing it right means proper attention to lapping of building paper and flashings to shed water when there is a failure.

Carpet Staining

Staining of carpets along the wall, most commonly along the outside wall but also along some interior walls, has been encountered with increased frequency recently. The problem is compounded by the fact that the stains are impossible to remove.

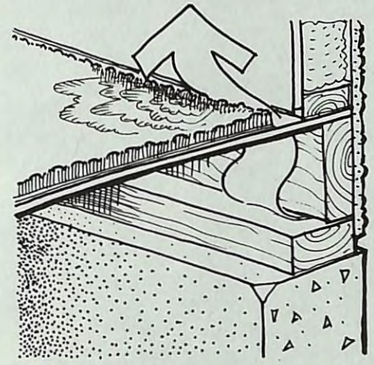
The popularity of light coloured carpets has made the problem worse, as it has made the stains visible. We can't insist that everyone use dark coloured carpets (on the theory that if you can't see it, it's not a problem).

The stains are causing builders and the Warranty programs considerable concern, but there is no certainty about who is liable for this problem.

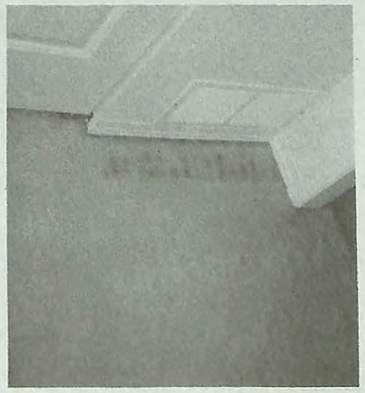
How can we avoid the problem? What is causing the problem?

Suggestions have been made that code requirements for sealing the building envelope have altered the air flow patterns in the house, resulting in the carpet fibres acting as a filter to airborne contaminants. Polluted urban environments contribute to the problem, but fundamentally they are not the cause.

The physics of the problem are that fine dust and dirt particles are being deposited on the carpet at air leakage points. Air leakage is driven by pressure differences from one part of the house to another or from outside to inside. The air movement is always from areas that are positively pressurized to areas that are under negative pressure. If the area is polluted, the air will carry the pollutant and deposit it on the carpet. Like a venturi tube, the air flow slows as it enters the large space, so any particles are deposited. The concentrated air flows at some leakage points accentuate the staining.



The pressure differences can be caused by stack effect, or most commonly in houses with forced warm air heating systems, by the leakage of air from leaky ducts. Forced warm air systems are suspect because the ducts in the basement or crawlspace can pressurize the space relative to the rest of the house. The ducts usually are not sealed, (up to 30% air leakage is not uncommon) effectively pressurizing the crawlspace or basement.



Concrete foundations add to the problem as they give off moisture via capillarity which then picks up the pollutants in the positive areas and deposits them in the negative areas. The concrete should be sealed against capillarity.

The stains can also be seen on the second floor, especially when you have a roof space next to an upper floor wall. The air passing under the wall plates moves exterior air inward, staining the carpets. Air can also leak at the rim joist which then enteres at interior walls. Infiltration leakage will happen anywhere below the neutral pressure plain (typically near the middle of the house).

How can the staining be avoided?

Much work remains to be done to investigate the issue and identify solutions. However, a number of suggestions can be made to reduce the problem.

- Crawlspaces should have a relief vent to keep them in a negative pressure in relation to the rest of the house. The balance of the house should be kept at an even pressure.
- Ducts should be sealed, especially if they run in a crawlspace.
- Penetrations in the envelope should be air sealed.
- Airsealing of the house should be more carefully done.

Anyone who has encountered these problems, or has some thoughts on the issue, should contact the CHBA-TRC as a detailed investigation is being planned.

The Bermuda Triangle:

Airtightness, Ventilation, and Insulation

Peter Moffat

In the last issue of ***Solplan Review*** *(Jan/93), M. Swinton and J. Reardon examined the potential for energy efficiency in new houses resulting from improvements in airtightness. These two NRC researchers concluded that little potential exists, given the low efficiency obtained from current ventilation practices. They argued that if we further tighten our houses for reasons of energy efficiency, we will need to ventilate our houses at higher rates to maintain air quality, for a net zero gain.*

I contend that Swinton and Reardon are wrong, especially for B.C. houses, but also for other Canadian locations. In fact, reducing air leakage in the leakiest new houses is probably the single greatest opportunity for cost effective energy reductions in Canadian housing. And I believe that it is both necessary and practical to include a minimum airtightness standard in the soon-to-be-released National Energy Code. But first let me begin with a return trip to the territory where Swinton and Reardon got lost - the Bermuda Triangle of Airtightness, Ventilation, and Insulation.

Misconceptions

The easiest way to get lost is to define a typical new Canadian house based on the average measured airtightness statistics while ignoring the range and total number of houses. It is better to model a series of housing archetypes, including some tight and some leaky houses, as we would find in the real world. The number of houses represented by each archetype should correspond with projected growth rates for the housing stock. This approach would reveal the potential for savings within the very large numbers of houses which lie far on the leaky side of average. Swinton and Reardon paid no attention to the range of housing airtightness values or the very different growth rates seen across the country. Manitoba and Saskatchewan, with virtually zero growth, had almost as many houses included in the NRC study as Ontario, where 36% of housing starts exist. B.C., which accounted for 25% of all housing starts was treated as an airtightness anomaly.

The B.C. Experience

Rather than being considered an anomaly the B.C. experience offers valuable lessons for anyone trying to reduce energy consumption in new housing.

The airtightness requirements of the National Building code have been enforced much more rigorously in B.C. than in other parts of the country since 1987. As well, the ventilation section of our building code has required some amount of balanced and continuous mechanical ventilation in all houses since 1989. In 1992 B.C. introduced minimum insulation levels into the provincial building code for the purpose of conserving energy. They are now in the process of increasing those minimum insulation requirements, based upon a lifecycle cost analysis. So what is to be learned from all this activity? Why, despite the systems approach to airtightness, ventilation and insulation, have B.C. houses remained as leaky as ever?

Airtightness

First, we need to clarify why our houses leak the way they do. The average measured airtightness of B.C. houses in the 1989 NRC survey was over 6.0 ACH @ 50 Pa, with some well above 10. The simple explanation for these West coast sieves, is that unlike most other parts of Canada, B.C. coastal housing is built mostly above ground. When this is combined with the other prominent features of coastal housing, a recipe for a leaky house is created: irregular housing shapes, with the highest square footage in the country, a high ratio of glazing (including skylights) to total envelope, twice the number of fireplaces than the Canadian average, forced air ducting located outside the heated envelope, heated crawl spaces with leaky vents, local manufacturing of low cost, loose fitting aluminum windows.

Just as important is the lack of consumer feedback. The builder who sells a leaky house doesn't lose customers. The house may be uncomfortable, but unlike Winnipeg, the occupants won't turn blue. The B.C. home owner can easily end up paying the same heating bill as their cousins in Edmonton, but surprisingly no one seems to think this is odd.

I contend that if a southern Ontario builder constructed a Vancouver style house, the house would be no tighter than the average new home in B.C. Thus, building styles and market forces, not building skills, explain much of the difference between houses in B.C. and elsewhere in Canada.

So why didn't the enforcement of the 1985 National Building Code airtightness requirements do the job? Three reasons: use of inappropriate materials and techniques, a too-subtle approach that focused only on sealing penetrations into cavities, and a reliance on a prescriptive standard with verification by visual inspections.

Builders in B.C. have been spending an estimated $300 extra per house on air sealing since 1987. Acoustical sealant, 6 mil poly, and the red air barrier tape are being used in most spec houses. Unfortunately neither insulators nor inspectors were trained in these new air sealing procedures. Beads of acoustical sealant are so thinly applied that they dry out and are ineffective. Acoustical sealant is being applied in locations that are permanently exposed to air, against manufacturers instructions. Where polyethylene has a structural backing the inspectors require only a 4 inch overlap, with no sealant. (This would be an acceptable practice for a moisture barrier, perhaps, but is ludicrous for poly used as an air barrier.) Polypans are stapled, cut up, and left to leak.

By focusing on cavity penetration routes all non-cavity air leaks have been ignored. For example, the sometimes a large crack between the bottom sill of exterior walls and the subfloor is not considered a cavity so it is not being sealed. The subsequent leakage through the floor crack has resulted in a loss of comfort and energy efficiency, as well as staining of light coloured carpets, a problem that is becoming a nightmare for the B.C. flooring industry.

A visual inspection of the air sealing measures confirms that materials are in place. When the municipal inspection is complete and the insulator leaves the house, the drywaller destroys with his knife the little that may have been achieved by the insulator's poor techniques and materials. One only has to watch an average B.C. drywaller at work to appreciate their total lack of concern for the integrity of an air barrier.

In retrospect, it is not surprising that the net effect of code prescribed air sealing has been a lot of sound and fury, signifying nothing. And yet the drama has contributed to a much different perception of airtightness by the housing industry. Building officials, builders, homeowners and salespersons are frequently convinced that our new houses are now airtight. This misconception about airtightness has provided a convenient explanation for a whole raft of problems in new houses, and is leading to inappropriate investments in both ventilation and insulation.

Hyper-Ventilation

New houses in B.C. are being hyper ventilated because airtightness is perceived as the cause of air quality and moisture problems. However, moisture problems in particular are not unique to new or tight homes. Mold growth, rotting floor joists in crawl spaces, damaged windows sills, painting problems in bathrooms, musty odors are all too prevalent even in houses with 20 ACH @ 50 Pa.

> *. . . the net effect of code prescribed air sealing has been a lot of sound and fury, signifying nothing.*

The Ventilation section of the B.C. Building Code requires some balanced and continuous mechanical ventilation. The most typical application in forced air houses is the connection of a fresh air duct to the return air plenum. Dehumidistats are wired to turn on a quiet, powerful bathroom fan and the furnace recirculation blower. This system is an excellent low cost solution for tight houses, especially in the warmer coastal areas. Unfortunately, the addition of exhaust fans with poorly fitting dampers and the make-up combustion air ducts directly connected to the return air plenums is making houses hyper-ventilated.

I find the most glaring example of hyper-ventilation is when houses in the 4 to 10 ACH @ 50 Pa range are built with HRV systems. The majority of air change in these houses will by-pass the heat exchanger, making the HRV uneconomic. Misguided home buyers spend $3000 on an HRV, without bothering to confirm that the house is tight enough to benefit.

HRVs are an excellent system for ventilating a tight house. Unfortunately the HRV has become an over-all fix for poor drainage, lack of a well designed moisture barrier under slabs, lack of a recirculation systems in radiantly heated houses, and lack of insulated, thermally broken window frames. Even poor air quality in master bedrooms, a common concern with HRV purchasers, is better addressed through recirculation of air unless the house is built extremely airtight.

Insulation Mania

In B.C. minimum insulation requirements have been introduced into the local Building Code before airtightness has been properly addressed. A Technical Advisory Committee (TAC) to the Building Standards Branch is using life cycle cost analysis to determine the optimum insulation levels for new houses. This analysis has virtually ignored infiltration and exfiltration. Part of the problem is with the HOT2000 heat loss program which the TAC used to model energy use in the typical new B.C. house. The natural infiltration model in this program is crude and consistently underestimates air leakage by a factor of two or more. (I understand a new model is in the works.)

Where models have failed to show the potential for air leakage control, field measurements have succeeded. Five typical new houses in B.C. were tested for natural infiltration during the 1989 Airtightness Survey conducted for NRC (the same study used by Swinton and Reardon to establish average air leakage

rates). The air change values were based on door fan tests, but the five houses referred to here were also tested with tracer gas to measure the air change under natural weather forces. The tests were conducted in late March, when outdoor temperatures were fairly mild, in the 9oC range. Yet the actual air flow through these five house was enormous, averaging 100 L/s over the one week test period. With this kind of air flow occurring, extra insulation is about as good as putting on a second down coat when someone is blasting masses of frozen air up your pant leg.

Hopefully the TAC will repeat its analysis and use the AIM2 infiltration model developed by Wilson at the University of Alberta. The model achieves a much higher accuracy by separately modeling chimneys and creating an interaction term between stack and wind effects. These factors are particularly important for B.C. houses which have an average of 2.5 fire places per house, a furnace chimney, and mandatory bathroom fans often venting through the roof.

Air tightness Testing: Where there is a will there's a way

Hyper Ventilation and Insulation Mania can only be corrected by introducing a minimum airtightness standard that would be enforced by performance tests. The B.C. experience has shown the folly of relying on prescriptive codes and visual inspections. A performance test is not a new idea and is currently the practice followed in the R2000 program.

Builders as a group have strongly resisted suggestions that all new houses be performance tested. The usual concerns are with increased costs of construction, complexity of equipment and procedures, responsibility for airtightness, and regulation of tests. I believe all of these barriers can be overcome, with a bit of creative planning. The benefits of a performance test clearly out weighs the cost, as I believe the B.C. experience proves.

Cost and Complexity:

It is time to redesign the test equipment and procedures used for airtightness testing. The sophisticated and accurate CGSB procedure, used by the R2000 program, is more accurate than necessary. A couple of choices exist for simplifying the CGSB test equipment and procedures.

One proven option is to use the Air test used by the B.C. Hydro Power Smart Home Improvements Program. A single flow measurement is taken at negative 20 Pa. The operator uses a single pressure gauge for reading both house and fan pressure. The leakage of the house is determined from a look-up chart. Standards are specified in leakage areas, so no one needs to work out the volume of the house. In fact, no calculations are required at all.

Another option is the ELA tester, an approach invented by Sheltair Scientific, that is even easier than the Power Smart Test, and yet as accurate as the CGSB test.

Unlike the CGSB test, the Power Smart Air test does not require the sealing of flues, ventilation systems, or combustion and make-up air ducts. This simplified set-up saves time, and is more appropriate for rating how the house performs under normal operating conditions. In B.C. there are now over 30 of these simplified door fans in the hands of insulation contractors doing retrofit work on electrically heated houses. The equipment is in daily use and is proven to be within the skill levels of the tradesmen, who are given a simple video tape course and manual.

Responsibility and Quality Control:

The Plumbing Code offers an excellent precedent for performance testing of systems that can not be visually inspected. The plumber is responsible for setting up a 24 hour pressure test for water lines, and then calls for an inspection by the municipality. The municipal inspector attends the tests to verify the results. The builder is only indirectly involved with the test. In essence, the plumber is contracted not only to install the plumbing, but also to obtain the approvals required by the plumbing code.

The logical choice for a trade that can become responsible for airtightness of houses is the insulator. It is the insulator who should obtain the approvals, and demonstrate that the house meets the minimum airtightness standard of the Energy Code.

Conclusion

The path out of the Bermuda Triangle of Airtightness, Ventilation, and Insulation is to include a minimum airtightness standard in the Energy Code.

The lessons from B.C. show that relying on a prescriptive code for air leakage control is disastrous. In B.C. it has created a misconception that houses are tight, lead to new houses being hyper ventilated, and placed minimum insulation levels in the code before minimum airtightness levels. For B.C. and other communities in Canada, mandating a simplified airtightness test procedure is the only way to achieve the enormous potential for energy savings in the leakiest houses.

The Swinton and Reardon study is crucial, because these two individuals have a major influence on the content of the National Energy Code. If their wrong conclusions are allowed to stand, the same mistakes made in B.C. will be repeated at the national level.

Peter Moffatt is a building science research consultant working for Sheltair Scientific Ltd. As part of his research work at Sheltair, he recently investigated the long term potential for reducing energy consumption in the residential sector of British Columbia.

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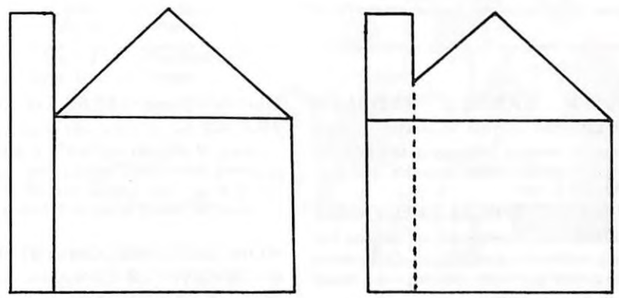

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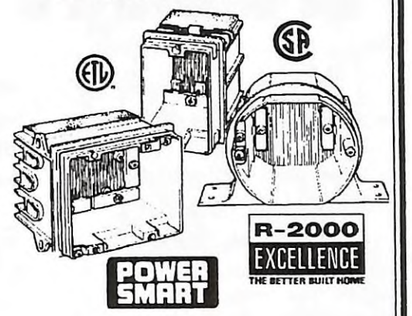

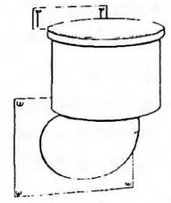

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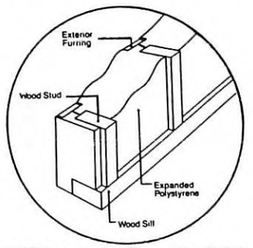

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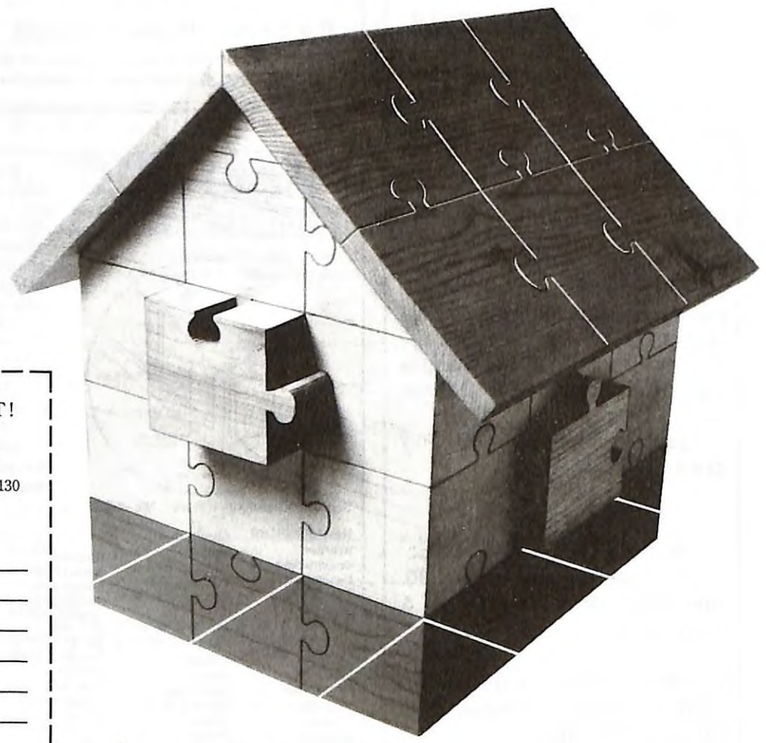

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The Builders' Show

1993 NAHB Show in Las Vegas

The annual meeting of the National Association of Home Builders, with 60,000 delegates has got to be one of the biggest shows around. In addition to the usual business and technical meetings, the centrepiece is the trade show that takes over the largest convention centre in the USA ("bigger than 4 football fields under one roof") and is a real extravaganza.

When was the last time that you saw someone's name spelled out in the water droplets of a fountain? (Just one of the features of the Koehler display).

The show is big - so big you need good walking shoes and be determined to spend several days if you want to see it all. Getting around gives you a good workout!

Who's there? All sectors of the housing industry are there. The small manufacturers launching new products are there, as are all the major players. However, there's more people selling taps and tubs and appliances than insulation or heating and ventilation equipment.

The highlights?

Indoor air quality

Indoor air quality is emerging as THE issue for the 1990's. Major manufacturer's are getting into ventilation equipment, including heat recovery ventilators. In many respects, the Americans are where the Canadian industry was 6-8 years ago. You'd think that the corporations would have done their homework and looked at the Canadian scene, to learn from our mistakes, but it doesn't seem to work that way. A couple of HRV's displayed there seemed crude and amateurish. Others forgot about such fundamentals as defrost drains, efficient motors, unit sizing, etc.

Some of the companies with new products, or with their nameplate on established equipment include Broan, Honeywell, Thermax, Panasonic. At the same time, established companies such as American Aldes, vanEE, and Environment Air were there.

We know the difficulty the housing industry has had in dealing with ventilation systems in Canada, even though we've had the research and educational support of the R-2000 program, CMHC, NRC, and various provincial agencies. There is still a long way to go before everyone in the field is comfortable and can install ventilation systems that work effectively.

We should be concerned about how the Americans handle the situation because the popular media spills over into Canada. If there are going to be problems in the US, and they get blown out of proportion, they are going to create some problems for us on this side of the border. Don't be surprised to see more headlines screaming about problems with new housing equipment.

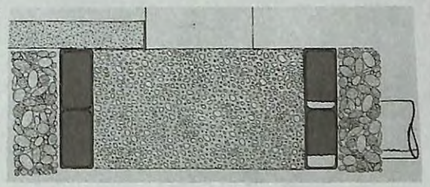
Insulating formwork systems

There are many concrete formwork systems that use polystyrene forms which remain in place providing insulation. They have originated as alternate foundation formwork, offering a way to have full depth insulated foundations: they sandwich the structural concrete between two layers of insulation, held in place with plastic ties or in plastic stacking blocks.

After pouring concrete, you provide some protection at grade, and on the interior attach panel material, and viola: a finished and insulated basement. In concept, they are a neat structural system, easy to reinforce whenever needed, and you don't have to strip forms before carrying on with construction. A bonus is that the insulation protects the concrete when it's setting up, so the concrete doesn't dry-out as quickly, thus making a stronger concrete, and in cool weather, there is frost protection for the concrete.

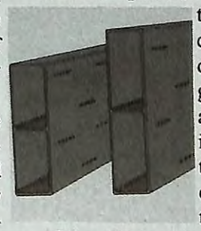
Many of these systems can be used above grade - so they offer an alternative to conventional framing. With the recent price increases in wood, the cost difference for some of these wall systems may not be as great as in the past. As a poured in place system, it should be easier to achieve airtight construction.

The only downside to some of these systems is the insulation values. The manufacturers of some systems make outlandish claims (as high as R-50 ??), although most would have an effective R value well under R-20, but with some modification, higher levels can be attained.



Form-A-Drain™

This is a simple but clever idea: a self draining footing form. It is a hollow PVC extrusion, perforated on one side, that is used to form foundation footings. Once the concrete is placed, the form stays in place as the perforated hollow channel becomes the drain tile. Thus in a single step footing forms as well as drain tile is installed. Special fittings are available for corners and connections to drain pipes. At a cost of about $1-2 per lineal foot, this could be a winner for many situations.



Form-a-Drain was developed by the CertainTeed Corporation, and will be on the market in April.

EMR/CANMET NEWS

The Canada Centre for Mineral and Energy Technology (CANMET) is the research and development arm of Energy, Mines and Resources. EMR/CANMET's Buildings Group works with industry to develop and commercialize the technologies to make Canadian houses more energy efficient. With the support of the Buildings Group, Solplan Review presents this information on some current CANMET projects. For more information contact: Energy Efficiency Division, EMR/CANMET, 580 Booth St., Ottawa, K1A 0E4.

B.C. Advanced House Ventilation

This home will incorporate many new innovations in its heating, ventilation and cooling system. The mechanical system will help provide the future homeower with the best in a healthy, comfortable and controlled environment. Further the environmental utility bill will be very low when this system is applied into a quality home such as this. The new Eneready Ventilation Zone Control System demonstrated here will enable the Eneready vanEE HRV to provide enhanced exhaust performance for each of its four bathrooms while the same system maintains a continuously fresh environment.

Qualities of a 'Good Practice' System

One of the principal reasons home owners request ventilation is for health and enjoyment of fresh air. A shortage of fresh air is something approximately one half of the people will notice when they first enter a home. Freshness depends on proper ducting layout and installation. In part this requires that the HRV exhaust be ducted so it can effectively collect exhaust air at a high level from the rooms which need the exhaust most - the kitchen and bathrooms. Effective exhaust collection also allows the overall ventilation system to be operated at a lower rate while still maintaining freshness. A lower continuous rate also helps maintain desired interior moisture in the winter while also saving fan motor and heat loss energy. Of course this ventilation system or any central ventilation system must be thoroughly duct sealed. Like any good system this also allows for room by room adjustment of air flows after system completion. This requires that appropriate ventilation grills (which are actually values) be used to make this possible. This is in contrast to using heating registers where the sizing of the duct crudely determines balance.

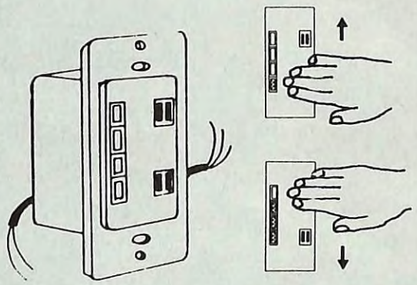
Current System Challenges

Since HRV's were first introduced into housing it has been difficult to apply them to serve two very different masters, fresh air and exhaust air requirements. Fresh air needs are generally small but must be continuous. This rate must also be adjustable to some degree to suit varying occupancy and seasonal change. While a continuous low rate exhaust is a big advantage in the drying out of a 'wet' bathroom and 'skimming' lingering odours off a kitchen ceiling, by itself it is not enough. For short periods the exhaust rate in these rooms must be boosted, and within reason, the more the better. Efficient, compact units have high internal air flow resistance. When the fan motor speed is increased core airflow resistance quickly builds up, choking off the airflow increase. This system limitation makes it difficult to serve bathroom needs economically with equipment sized appropriately to serve the continuous needs.

The Solution

Ventilation zoning is the solution. In the B.C. Advanced Home the HRV exhaust is ducted from the kitchen (general room exhaust - a range hood serves peak needs) and each of four bathrooms. Normally these grills are each adjusted to approximately 10% open so all five locations share the continuous exhaust rate equally.

The temporary bathroom exhaust boost is provided primarily by fully opening that room's whisper power grill. This action will divert approximately 3/4 of the system's exhaust capacity from that room. The **PoshTime™** switch which powers the grill open provides an additional exhaust boost by simultaneously switching the HRV to high. At the end of the selected twenty-eight minute 'boosted' time period, the grill returns to normal setting, the HRV to continuous rate and the other exhausted rooms regain their share of exhaust rate.

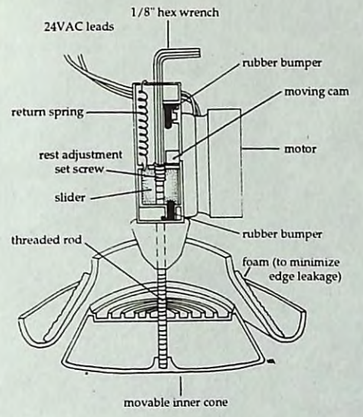


PoshTime™ Switch

This is an attractive 4 in 1 electronic timer. It uses two infrared 'pads' to detect your on and off command. When switched on it illuminates four soft green light emitting diodes (LEDS) indicating that it has begun counting down twenty-eight minutes (in auto set mode) at seven minutes per LED. All or part of the full twenty-eight minute period may be used. For those who enjoy a small challenge Posh can also prove timing for one, four and eight hour periods. For maximum safety and installation flexibility this control is 24 VAC.

'Whisper' Power Grill

The **'whisper' Power Grill** is a 24 volt electrically activated version of the 4" round VLK - 100 'whisper grill. It's role in a centrally-ducted system is to temporarily focus high-speed exhaust to the room most needed.



When power is applied, the moveable inner cone extends outward 7/8 of an inch. This fully opens the grill for increased air flow. When power is cut, the cone spring returns to the rest position.

As with the standard 'whisper' grill room-by-room division of the normal, continuous exhaust is still possible. This is done during installation by adjusting the rest position to any point from fully closed to ¼'' open. Once locked, the inner cone can be unwound, cleaned and replaced by the homeowner with recalibration.

In the next issue we will cover other unique features of the integrated system including its four zone air circulation/ heating/cooling filtration system.

Advanced Houses Displayed at the Marketplace of Ideas

Celebrating CHBA's 50th Anniversary, the Marketplace of Ideas was a feature at the annual convention. With the assistance of CANMET's Buildings Group and CMHC, a major display focusing on housing technology through the years was presented to delegates.

The housing built in the 1940's and 1950's was a far cry from what we build today. When they say ''they don't build them like the used to...'' it's right - we build them much better!

Compared to the practices of 50 years ago, the Advanced Houses built today are rocket science. All 10 Advanced Houses were on display, showcasing the unique features and technologies being incorporated. As most of the houses are still under construction, (only Manitoba and Saskatchewan Advanced Houses are complete at this time) displays showed the progress of each house, and some of the products and technologies that are being incorporated.

Advanced Houses Videos

A number of projects have prepared or are preparing videos showing the construction of their house and highlighting the technologies being demonstrated in each house. Those who are unable to visit one of the Advanced Houses, but would like to see what the house looks like and what kinds of innovations have been used, should contact the Advanced House they are interested in, or contact CANMET Building's group, and they will pass on your request.

Maison Novtec Update

2x4 Exterior walls

The Maison Novtec in Montreal shows that there are alternatives to 2x6, 2x8 or double wall framing to achieve a high R-value. The R-30 walls are achieved using 2x4 framing with batt insulation, along with two layers of 1½'' high R-value rigid insulation on the exterior.

The exterior layer of rigid insulation is also the backing for the brick veneer, which is a ½'' tile that sits in a pre-formed groove in the polystyrene rigid insulation. When installed, it looks just like the regular brick, except that it doesn't involve the use of full 3½'' bricks, does not require specialized trades to install, and can be installed in most weather conditions.

Shallow Foundation

This house also demonstrates the use of an insulated slab-on-grade with insulating skirt, emphasizing that you don't always need to put in deep foundations in a cold climate.

Conventional deep foundation walls are built so that the footing is located below frost line as a convenience, but it's not necessary to do the full excavation and put in a basement if proper frost protection is provided. The insulation skirt in effect raises the frost line in the vicinity of the house.

This foundation design has been allowed by the building code for some time, but has not been used often. Yet a slab-on-grade can reduce construction costs substantially, and resolve many problems on difficult sites.

Technical Research Committee News

Canadian
Home Builders'
Association

The Technical Research Committee (TRC) is the industry's forum for the exchange ofinformation on research and development in the housing sector. Anyone with a problem, technical question of suggestions for areasthat need to be investigated is encouraged to contact their local Home Builder's Associationtechnical committee or the TRC directly at: Canadian Home Builders Association, Suite 200, 150 Kaurier Ave. West, Ottawa, Ont. K1P 5J4
Tel: (613) 230-3060

Richard Lind New TRC Chairman

After two years in the Chair, Bruce Clemmensen has retired and Richard Lind from Bridgewater, Nova Scotia has stepped in.

Canadian Code for Energy Efficiency in New Houses (1995)

As reported previously, work is continuing on the development of a new model energy code. The TRC has been active providing input to the committee drafting the proposed standards. Key suggestions being made include:

- The energy code should be a stand alone document, so that each province will review and consider its adoption separately.
- The code should be easy to administer. This means that is should be written in a clear and simple format.
- Cost/benefit analyses must be carried out for each measure being proposed, to ensure that the regulations don't impose under costs for homeowners.

Building Materials Standards

The Manufacturer's council has been concerned that with changing trading patterns due to Free Trade and greater international trade in manufactured products, products appearing on the Canadian market do not always meet Canadian standards. Codes and standard changes in different countries vary, and there a pressures to speed the harmonization of the standards, especially with US standards.

As long as there are different standards, it is difficult for products to compete on an even footing, as there could be substantial differences. For example, the way R values are labelled in Canada and the USA is different, so a Canadian R20 insulation batt may not provide the same insulating value as an American R20 batt.

Products with different standards include insulation, plumbing, and roofing products.

R-2000 Technical Standard

The proposed changes to the Technical Requirements are now being finalized by the consultant. Suggestions from builders and program partners in all regions have been considered.

The proposed changes in general recommend that:

- the Energy Performance Targets be modified to favour smaller houses;
- that design evaluation methods be adjusted to use more accurate assumptions (effectively reducing the energy target by about 20%);
- introducing eco-features, (through a series of options to provide a variety of options to suit many house types). The include use of low emission building materials and finishes inside the home, water conserving plumbing fixtures, and resource efficient building practices by optimizing use of new materials and encouraging maximum use of recycled products where appropriate.

The changes that will be adopted and their implementation timing is still to be decided.

House Construction Costs 1977 vs 1991

How have construction costs changed over the years? Have prices really gone up?

An interesting study was done recently for the Innovative Housing Grants Program of Alberta Municipal Affairs. The study compared house construction costs in 1991 to costs in 1977 and tried to determine what has been the impact of regulations on housing costs.

1977 was chosen as a benchmark because detailed information for that year is available from an earlier study which analyzed the costs of producing a moderate-cost house in Alberta. Costs for 1991 were obtained directly from suppliers, subtrades and home builders in Calgary, Edmonton and Lethbridge.

The Alberta Building Code and other local building standards and by-laws in force in 1977 and 1991 were also reviewed. Differences in industry practices and finishing norms in the two reference years were also noted.

To make the comparison in real terms, the costs in 1977 were adjusted to 1991 dollars using the Consumer Price Index (C.P.I.). Because there have been significant changes in what the marketplace considers moderate-cost homes, the study also compared housing affordability in the two study years.

The 1977 starter home was a 1,080 sq. ft.. modest single-bathroom, three bedroom bungalow on a basement. A typical moderate house in 1991 was a 1,570 sq. ft., four-level split house finished on three levels with an attached double garage. A model of this type was adopted as the 1991 study home.

Four cost scenarios were investigated to see what the cost difference was between 1977 and 1991 and why.

Cost of Building the 1977 Home in 1977 and in 1991.

Table 1 shows that there has been a big drop, in real terms, in the hard construction costs since 1977. The largest drop is in the cost of labour which has been influenced by a number of factors including increased productivity, a shift from site labour to shop labour, and fewer unionized construction workers in 1991 than in 1977.

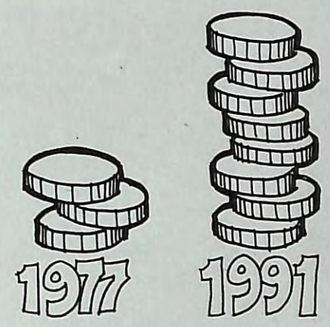
Code changes have resulted in cost increases averaging 4.6%, while general market upgrades and changes in industry methods have had a net effect of increasing costs by an average of 1.7%. Taxes on construction have increased and represent the difference between a 5% Federal Sales Tax on construction materials in 1977 and a net Goods and Services Tax of 4.48% on labour and materials in 1991.

Cost of Building the 1977 Home in 1977 and the 1991 Home in 1991.

Table 2 shows the construction costs of the two model houses have stayed constant in Calgary, decreased in Edmonton and increased in Lethbridge.

Total costs to the builder of building and marketing moderate homes for the first-time buyer have decreased by approximately 12% in Calgary and 15% in Edmonton but have increased by 2% in Lethbridge. The main reason for the increase is that lot prices have risen more in Lethbridge than in the other two communities (or dropped less in real terms).

Large tax increases have taken place since 1977, primarily for three reasons. One is that taxes are based on the value of the house and the typical model increased substantially in size and contained more amenities from 1977 to 1991, thus this increased its value. The two other reasons



stemmed from the introduction of the goods and services tax. This tax applies to materials and labour costs, instead of just material costs as did the old federal sales tax. The G.S.T. also applies to the cost of a serviced lot so this results in a substantial tax increase. It should be noted, however, that this increase did not occur suddenly in 1991 as the F.S.T. on materials was increased from 5% to 9% and 13.5% in 1990. depending on material.

Changes in industry standards as a result of market demand have only increased costs moderately in terms of cost

Table 1. Cost comparisons: Cost of Building 1080 sq.ft. bungalow in 1977 vs. 1991

Cost Item	Calgary			Edmonton			Lethbridge		
	1977 cost	1991 cost	change	1977 cost	1991 cost	change	1977 cost	1991 cost	change
Cost of Labour	$24,737	$15,077	- 32%	$25,594	$14,663	- 43%	$25,224	$15,553	- 38%
Cost of Materials	$36,233	$29,483	- 18%	$37,738	$30,735	- 19%	$36,644	$31,284	- 15%
sub-total	$60,970	$44,560	- 27%	$63,332	$45,398	- 28%	$61,868	$46,837	- 24%
Impact of code/standards changes		$1,978	+ 4.4%		$2,157	+ 4.7%		$1,990	+ 4.2%
Increasue due to industry/arket norms		$893	+ 2.0%		$866	+ 1.9%		$538	+ 1.2%
Sub total	$60,970	$47,431		$63,332	$48,421		$61,868	$49,365	
All taxes on construction	$1,818	$ 2,125	+ 17%	$1,869	$2,174	+ 16%	$1,832	$2,212	+ 20%
Total construction costs	**$62,788**	**$49,556**	- 21%	**$65,201**	**$50,595**	- 22%	**$63,700**	**$51,577**	- 19%

Table 2:
Cost comparison: Cost of Building 1080 sq.ft. bungalow in 1977 vs. 1,570 sq.ft. split level in 1991

Cost Item	Calgary			Edmonton			Lethbridge		
	1977	1991	change	1977	1991	change	1977	1991	change
Hard construction costs	$60,970	$70,278	+15%	$63,332	$70,872	+ 12%	$61,868	$72,652	-17%
Soft costs	$24,200	$15,030	- 38%	$24,845	$14,120	- 43%	$20,910	$14,270	-32%
Total construction costs	$85,170	$85,308		$88,177	$84,992	- 4%	$82,778	$86,922	+5%
Serviced lot	$56,330	$39,500	- 30%	$56,740	$38,500	- 32%	$32,860	$31,000	- 6%
Total builder's cost	$141,500	$124,808	- 12%	$144,917	$123,492	- 15%	$115,638	$117,922	+2%
Profit (4% 1977; 6% 1991)	$5,660	$7,488	+ 32%	$7,246	$7,410	+ 3%	$8,094	$7,075	-13%
Price before taxes	$147,160	$132,296	- 10%	$152,163	$130,902	- 13%	$123,732	$124,997	+1%
Taxes	$1,818	$5,927	+226%	$1,869	$5,867	+214%	$1,832	$5,600	+206%
Purchase price	**$148,978**	**$138,223**	- 7%	**$154,032**	**$136,769**	- 11%	**$125,564**	**$130,597**	+4%

per sq. ft., but significantly in terms of total cost because of the increased size of the moderate home.

Affordability Comparison

Using a criterion of 30% of gross family income as the maximum spent on shelter, in 1991 a higher proportion of families in Calgary, Edmonton and Lethbridge could afford a moderate house than in 1977 in spite of the fact that the 1991 home was much larger, had more features and had been upgraded both by code requirements and industry standards.

Comparative Analysis of House Construction Costs, prepared by NRE Cost Consultants for Innovative Housing Grants Program, Alberta Municipal Affairs, Edmonton, AB.

Combined Ventilation & Forced Warm Air Heating Systems: do they work?

There are many ways to provide mechanical ventilation in houses; usually the question is how best to do it. This is an important consideration as CSA F326 (Residential Mechanical Ventilation Systems Standard) is being proposed to be incorporated in the Building Code.

Are systems that meet F326 effective?

A recent study by the Saskatchewan Research Council looked at houses with central ventilation systems connected to forced warm air heating systems that were supposed to meet CSA F326. Four Saskatoon houses (built between 1983 and 1986) were studied, two had heat recovery ventilators and two had central exhaust fans. Two of the houses met the R-2000 air tightness standard of 1.5 air changes/h at 50 pascals.

Measurements of ventilation rates, room air flows, duct leakage, sound levels, fan energy consumption rates and house depressurization levels caused by the operation of the ventilation system were taken.

Three of the four houses had ventilation systems with a ventilation capacity equivalent to 0.3 air changes/hour. The fourth had a measured air change rate of 0.22 ac/h. However, only one of the four houses could meet the minimum ventilation requirement of the CSA F326 standard based on individual room supply requirements.

The minimum ventilation requirement for the houses varied between 55 and 70 L/s (116-148 cfm). None of the houses were able to meet the 30 L/s (63 cfm) exhaust air flow requirement for kitchens, and only two houses were able to meet the 10 L/s (21 cfm) requirements for each bathrooms.

In the CSA standard, the houses must meet a minimum ventilation air capacity that is the greater of either the sum of the individual room requirements or 0.3 ac/h. In general, the systems had been providing satisfactory ventilation to the houses, and the occupants were satisfied with their performance. But using a strict interpretation of the F326 standard, all of the houses would fail the minimum ventilation requirements.

Significant air leakage was found in the ductwork in both the warm air distribution and in the exhaust air system in a number of the houses. One house was found to have 91% leakage in the warm air distribution system (only 9% of the air entered the warm air return grilles, the remainder of the air entered through duct leakage.)

House A

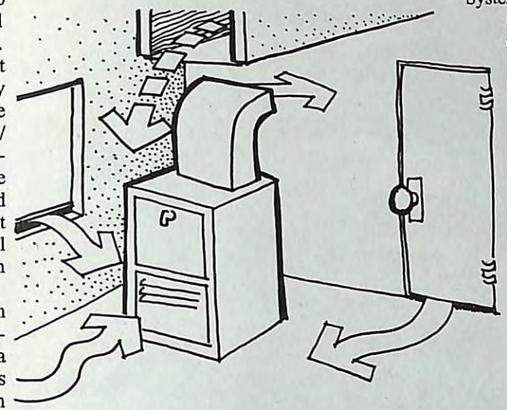
A three level split level house built in 1986, with an interior volume of 582 m3, forced warm air heating with a natural gas water heater with induced draft exhaust fan and a continuous pilot. Heat is transferred to warm the air through a fan coil. The ventilation system was an HRV directly connected to the warm air system. The return air ductwork is located at the main floor joist level.

91% of the return air flow leaked through the ducts - in other words the return air ducts weren't doing anything!

Occupants in the house complained that a pool of cool air tended to lie on the floor in the lower level after the front door was opened. As most of the return air flows into the leaky ductwork in the ceiling of the basement, the return air system does not reduce the stratification in the lower level of the house. A properly sized and sealed return air duct system would help avoid this stratification problem.

House B

A bi-level house built in 1985 with an interior volume of 431 m3. The heating is natural gas forced warm air furnace with atmospheric vented chimney. The ventilation system was a central exhaust fan connected to the bathroom and kitchen. A 127 mm diameter fresh air duct connected to the return air



plenum on the warm air furnace provides outside air. Air leakage through the return air flow system was about 26.5% of the return air flow.

House C

A split level house built in 1983 with an interior volume of 568 m3. The heating is natural gas forced warm air furnace with an atmospheric vented chimney with intermittent ignition and a stack damper. Ventilation system was a central exhaust fan connected to the bathroom and kitchen. The return air duct leakage was 37.9% of the return air flows.

House D

A bi-level house built in 1984 with an interior volume of 622 m3. The heating was a natural gas forced warm-air furnace with an atmospheric vented chimney. The ventilation System was a heat recovery ventilator. The air leakage through the return air system as 47% of the air flow.

Observations

It is difficult to generalize results taken from a sample of four homes. However, some interesting observations can be made. Duct leakage can be a big problem with ventilation systems. Although adequate flows are present at the fans, acceptable distribution is unlikely to happen unless sealed ducts are used. Standard metal ductwork installed without sealing will not perform.

Return air systems in warm air heating systems that use the joist spaces as a duct or plenum are also a problem. The common method of providing a return air path at the ceiling level in the basement is to nail a flat sheet of galvanized steel along the bottom of two parallel floor joists. This results in a large amount of air leakage, as the "duct" is not sealed at the joint between the galvanized steel and the bottom of the joists. This leakage causes the return air grilles to be ineffective and also can cause stratification of air to occur at the floor levels in the houses. For those houses relying on return air to provide adequate mixing, a more carefully designed return air duct system is required.

Testing Of Ventilation Systems In Forced Warm Air Combustion Heated Houses for Canada Mortgage and Housing Corporation Research Division Ottawa, Ont by Saskatchewan Research Council Building Science Division

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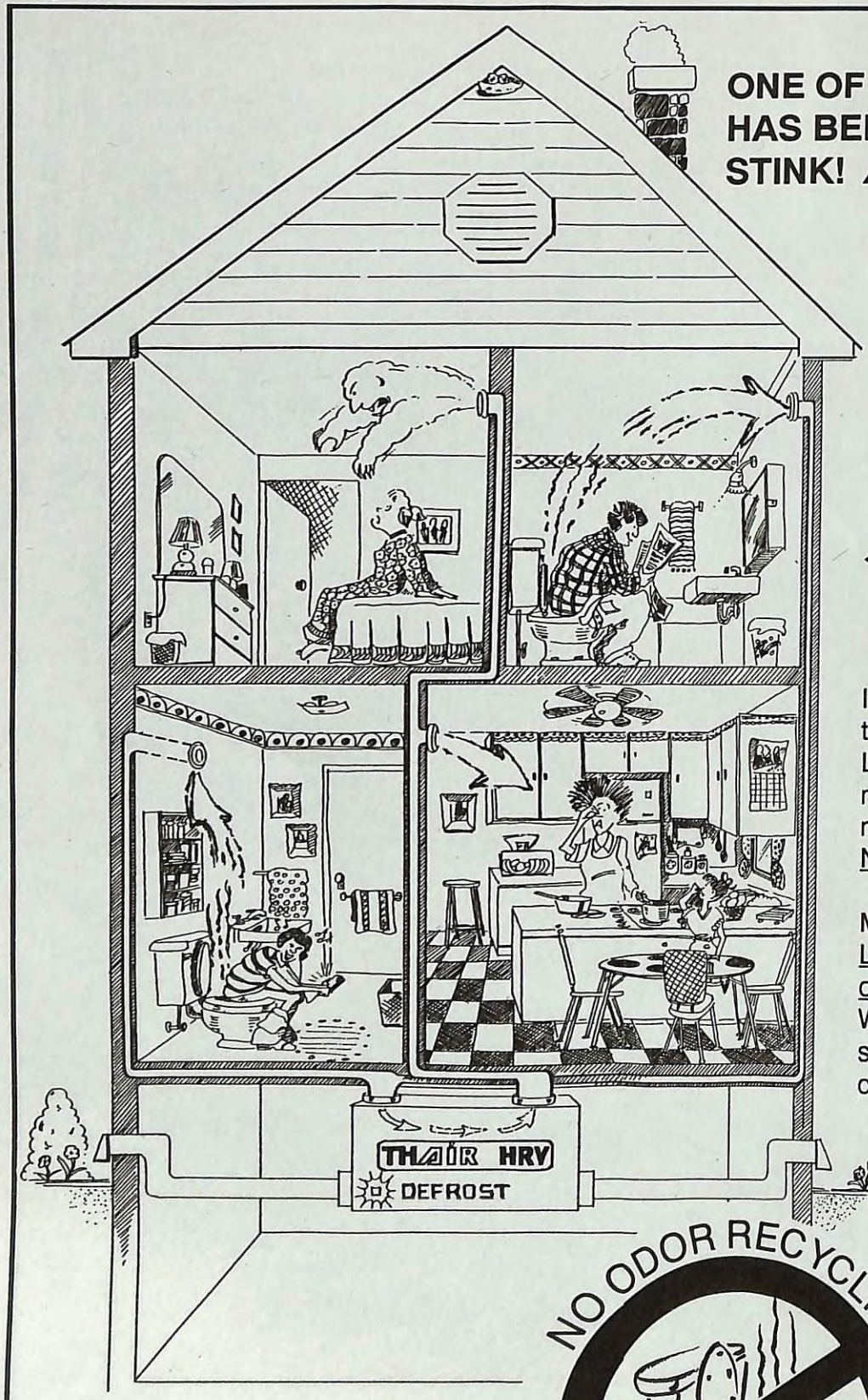

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